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(54) Image-Forming Device

(57) (Abstract)
(Problem)
The invention provides an image-forming device capable of selecting an optimum setting condition for developing even in the case in which new developing agent is supplied in the developing device.
(Means to Solve the Problem)
When toner is supplied in a developing unit 4, a print controller 6 selects an initial value as an optimum setting condition for developing. At the same time, the print controller selects from a plurality of charge potentials for a photosensitive unit 1, which are preset responsive to temperature and humidity, one optimum charge value for the time of developing at prescribed times. It selects the corresponding condition based on a history of temperature and humidity detected by the environment detector 19 at each prescribed time.

[1] Most Japanese names have multiple correct readings. The readings here are possibly correct.
[2] Most Japanese names have multiple correct readings. The readings here are possibly correct.

(Claims)

(1) An image-forming device provided with an axially rotating latent image holding unit for holding a latent image, and a developing device for making visual a latent image as a developing agent image by providing developing agent to the latent image holding unit, the image-forming device being provided with a temperature and humidity detecting means for detecting the temperature and humidity of the atmosphere in the image-forming device;
an image condition setting means for selecting from a plurality of setting conditions for developing that are preset responsive to temperature and humidity, for each prescribed time, one condition that corresponds to an optimum setting condition at the time of developing, the condition being based on the history of the detected temperatures and humidities that are detected over the prescribed times by the temperature and humidity detecting means; and
a developing agent supply means for supplying developing agent in the developing device,
wherein the developing condition setting device is set by selecting an initial value when the supply of developing agent is supplied in the developing device by the developing agent supply means.

(2) The image-forming device of claim 1 wherein the developing device is provided with a developing agent holding unit, provided rotating axially parallel to the axis of the latent image holding unit, and facing the latent image holding unit, that holds developing agent and provides the developing agent to the latent image holding unit,
the developing image holding unit being such that a developing bias, which is a direct current voltage superimposed on an alternating current voltage, is impressed between the developing agent holding unit and the latent image holding unit to cause the transfer of the developing agent that is on the developing agent holding unit to the latent image holding unit.

(3) The image-forming device of claim 2 wherein the developing setting means is set using the difference between the charge potential of the latent image holding device and the direct current voltage value of the developing bias as the setting condition.

(4) The image-forming device of claim 2 or 3 wherein the developing condition setting means is set using the voltage waveform of the developing bias as the setting condition.

(5) The image-forming device of any of claims 2 through 4 wherein the developing condition setting means is set using the speed ratio of the circumferential speed of the latent image holding device and the circumferential speed of the developing agent holding device as the setting condition.

(6) The image-forming device of any of claims 1 through 5 wherein the image holding device is such that a latent image is formed by exposing its surface, and the developing condition setting means is set using the condition under which the latent image holding unit is exposed as the setting condition.

Specification

Detailed Description of the Invention

(0001)

(Technical Field of the Invention)

The invention relates to an image-forming device provided with a latent image holding unit that holds a latent image and that rotates axially, and a developing device that makes visual the latent image as a developing agent image by means of imposing developing agent on the latent image holding unit.

(0002)

(Related Art)

Conventionally the developing agent, or toner, that is used in a developing device, or developing unit, that is provided in the image-forming device of copying machines, printers or the like that employ electro-photographic methods is affected by the influence of the moisture in the air around the image-forming device on the toner's triboelectric characteristics. This is true regardless of whether the toner consists of one or two components. This is because the surface of the toner resin and the surface of the silica or other external additive either absorb the moisture in the air or dehumidify. Generally, when toner absorbs moisture there is a tendency for toner to lose charge volume and for density to decrease; while when toner dries out, the tendency is for toner charge volume to increase, and density to increase. This toner absorption and drying out is a reversible, transient phenomenon, and it normally takes from a few hours to ten hours for the toner in the developing unit or the hopper to adapt to the amount of moisture in the air around the image-forming device.

(0003)

Subsequently, developing characteristics at any one time are dependent on both the amount of moisture in the air around the image-forming device and the time that the image-forming device has been in that environment.

(0004)

In a conventional image-forming device provided with a developing device, a developing condition setting means is provided in the image-forming device in order to compensate for the aforementioned dependence of developing characteristics on the amount of moisture in the air and the duration of location. The developing condition setting means sets a mode (hereinafter developing amount adjusting mode) that changes the setting conditions (hereinafter amount of developing) for developing, for example potential contrast. These changes are responsive to moisture content, the moisture content being obtained from information obtained by the temperature, moisture sensor (temperature, moisture detecting means) provided in the image forming means, this information being converted to an air moisture content value and then stored. In one known example of a developing amount adjusting mode, the calculated moisture content is recorded in memory at 1 to 15 minute intervals, and the DC element of the developing bias and the charge potential of the photosensitive unit are changed responsive to an average value taken over 8 to 24 hours.

(0005)

(Problems to be Solved by the Invention)

However, in an image-forming device that uses a conventional developing adjustment mode, depending on for example the toner bottle that is the developing agent supply means that is provided in the image-forming device, if the image-forming device is run in a mode for installing a new supply of toner (hereinafter supply installation mode) after for example the developing unit is exchanged or the toner in the developing unit is cleaned out, problems such as the following are likely to occur.

(0006)

The moisture absorption condition in the toner in the developing unit immediately after toner supply installation mode is substantially the same as the moisture absorption condition in the toner bottle. The toner bottle is normally sealed to shut out the external air so that so that toner does contact the external atmosphere. Therefore the moisture absorption condition in the toner bottle is substantially uniform and the same as the moisture at the time that the toner was manufactured. Conventionally, the degree of developing as determined by the temperature and the humidity detected by the temperature humidity sensor often continues to be used, even after the toner supply installation mode. Therefore, because this is not an optimum developing condition setting, there is a possibility image problems will occur. Either too much toner is loaded on the latent image holding unit which leads to toner splattering at the subsequent transfer region or the fixing region, or conversely not enough toner is loaded onto the latent image holding unit and the image density is thin or there is fading.

(0007)

One could consider using a service mode during toner installation supply mode to hand-set the developing amount adjustment mode condition. However, considering the service burden and the efficiency of the operation this is not preferred.

(0008)

The object of the invention is to provide an image-forming device that is capable of selecting an optimum development setting condition, even when new developing agent is supplied in the developing device.

(0009)

(Means to Solve the Problem)

The primary invention of the application is an image-forming device provided with an axially rotating latent image holding unit for holding a latent image that is formed by an exposure process, and a developing device for making visual a latent image as a developing agent image by providing developing agent to the latent image holding unit, the image-forming device being provided with a temperature and humidity detecting means for detecting the temperature and humidity of the atmosphere in the image-forming device; an image condition setting means for selecting from a plurality of setting conditions for developing that are preset responsive to temperature and humidity, for each prescribed time, one condition that corresponds to an optimum setting condition at the time of developing, the condition being based on the history of the detected temperature and humidity that are detected over the prescribed times by the temperature and humidity detecting means; and a developing agent supply means for supplying developing agent in the developing device, wherein the developing condition setting device is set by selecting an initial value when the supply of developing agent is supplied in the developing device by the developing agent supply means.

(0010)
(Embodiments)
Following is a description of embodiments of the invention, based on the attached drawings.
(0011)
(First Embodiment)
First is a description of the first embodiment of the invention.
(0012)
Fig 1 is a block diagram of an electro-photographic copying machine that is one example of an image-forming device that reads to the embodiment.
(0013)
As shown in Fig 1, the copier is provided with a photosensitive unit 1 made of amorphous silicon, which is the image holding unit; a primary charge unit 5; a developing unit 4, which is a developing device that employs single element toner; a toner hopper (not shown), which is the developing agent supply means; a high voltage power supply 17; a developing bias power supply 18; a fixing unit 12; and an environment sensor 19, which is a temperature humidity detection means that detects the temperature and humidity in the copier's atmosphere.
(0014)
Also, the copier has a controller 15 for controlling an operation unit (not shown) and image signals; and a printer controller 6, which is a developing condition setting means for control related to the electro-photographic image formation process, and for calculating the results detected by the environment sensor 19, etc.
(0015)
The primary charge unit 5 is such that a primary charging current value is controlled by signals sent from the printer controller 6 to a high voltage power supply 17.
(0016)
A laser 13 is such that the laser power output from the laser 13 is controlled by signals sent from the printer controller 6 to a laser driver.
(0017)
A potential sensor 22 is provided in the image region of the surface of the photosensitive unit 1 in order to measure the surface potential of the photosensitive drum 1 after exposure.
(0018)
The environment sensor 19 is provided in a location where it will not be affected by the increased temperature of the copier.
(0019)
In the photocopier, the primary charge unit 5 charges the surface of the photosensitive unit 1. Next, using a rotating mirror 11, the photocopier scans semiconductor laser light from the laser 13, which is modulated responsive to an image signal, shining it onto the positions to be exposed on the photosensitive unit 1, thus forming a latent image on the photosensitive unit 1. In the embodiment a regular developing method is used in which the exposed image region is developed with toner.
(0020)
Thus, the latent image that is formed on the photosensitive unit 1 is subsequently developed by the developing unit 4.
(0021)
Fig 2 is a block diagram that shows the control system for the electro-photographic type of copying machine that is employed in the first embodiment.
(0022)
A controller 15 mainly executes user input and display related to a control unit (not shown) that is provided in the copying machine, and controls and image-processes image signals from a reader (not shown) or a host computer (not shown).
(0023)
A printer controller 6 controls charging the photosensitive unit 1, exposure, developing, and other processes related to the electro-photographic image forming process. It also calculates the values that are detected by the environment sensor 9[3]. Additionally, the printer controller 6 is connected to a RAM 20, and a non-volatile memory 21 such as EEPROM.

[3] Should be 19

(0024)
The toner used in the developing unit 4 is a single component, magnetic posi-toner having a volume average particle diameter of 4-12μm. Its main binder is a polyester resin having a glass transition temperature of 55-65°C, a number average molecular weight (Mn) of 2,000-7,000, a weight average molecular weight (Mw) of 10,000-150,000. For 100 weight of the resin, as a charge control agent, a metal complex; as a wax, a low molecular weight polyethylene, a low molecular weight polypropylene, carnauba wax, etc in the region of 0.5-10 by weight are internally added. For 100 weight of the resin component, as a magnetic body, magnetite having an average diameter of 0.1-0.5μm, an iron oxide such as ferrite in the region of 65-110 weight are internally added.
(0025)
For 100 weight of the toner, 0.1-5 weight of dried pulverized silica, 0.5-5 weight of strontium titanate are added as an external additive.
(0026)
Fig 3 shows the relationship between the time that the system is left after the developing device's installed environment changes, and the amount of toner that is provided per unit of surface area, which is one indicator of developing characteristics. That is, the figure shows the relationship between the amount of developing and the strongly related transmission density of a solid black image.
(0027)
In the embodiment, DT (total) and DT (paper) are calculated from respectively the optical transmission density ratio of paper after toner has been fixed, and the optical transmission density ratio of reference paper. The transmission density is defined as the difference DT (total) - DT (paper), larger numbers indicating a larger amount of developing.
(0028)
In the experiment shown in Fig 3, two experiments were conducted. In one a transition was made from an atmosphere with a standard amount of moisture to an atmosphere that contained less moisture. In the other, the opposite transition was made. For normal temperature, normal humidity (23°C/60%) the amount of moisture in air was 10.5g/kg. At normal temperature, low humidity (23°C/5%) it was 1.0g/kg. The transition from normal temperature and humidity to normal temperature and low humidity was made in 3 days, and the transition from normal temperature low humidity to normal temperature normal humidity was made in 3 days, during which the transition of the transmission density was measured against time. No copying was performed in the periods between the samples, and the developing unit was left in the machine, not rotating. As a result it was understood that it took at least 20 hours for the toner in the developing unit to substantially adapt to the atmosphere outside the machine.
(0029)
Fig 4 shows the transmission densities in each of the atmospheres having differing moisture content after 3 days.
(0030)
In the embodiment, as Fig 4 shows, it can bee seen that there is a tendency for the transmission density to increase along with a reduction in moisture content. This is the normal trend. When the moisture content falls below 5g/kg the rate of increase of transmission density decreases.
(0031)
In the embodiment the environment sensor 19, which is a temperature, humidity sensor, outputs detected temperature signals and detected humidity signals, which are accumulated in non-volatile memory 21. Temperature and humidity data are stored in the non-volatile memory 21 at a regular interval, in the embodiment every hour. Also, as is shown next, data for the moisture content of the air (W) is stored.
(0032)
The temperature and humidity signals from the environment sensor 19 are converted to moisture content of the air and are overwritten. The moisture content of the air is the weight (g) of water in 1kg of air, and is obtained by the following formulae.
(0033)
(Formula 1)
$H=P/PS\times100(\%)$
(Formula 2)
$W=0.622P/\pi-P\times1000$H: Relative humidity (%)
P: vapor pressure (mmHg)
PS: Saturated vapor pressure (mmHg)

π: Total pressure (Normally 760MMHG)
That is, using formula 1, first P is obtained, PS being obtained by referencing a table in the non-volatile memory 21. Then W is calculated.

(0034)
In the embodiment, W is stored in the RAM 20 every hour, and after the average of 8 values is taken, the value is stored as the value Q in the non-volatile memory 21.

(0035)
Then, after power is turned on, the potential of the photosensitive drum 1 is controlled based on the value Q that is stored in the non-volatile memory 21.

(0036)
Concerning the potential control for the photosensitive unit 1, in order to control the charge potential VD (dark potential) and VL (light potential) of the photosensitive unit 1 at the developing position in the circumferential direction of the photosensitive unit 1, a prescribed potential is set that takes into consideration the attenuation of dark at the position of the potential sensor 22 in the circumferential direction of the photosensitive unit 1. The primary current value for the primary charge unit 5 and the laser power for the laser 13 are controlled by feedback and values are obtained in the following order: primary current control value, laser power control value.

(0037)
Fig 5 shows the relationship between the value Q set in the non-volatile memory by the embodiment and the VD charge potential of the photosensitive unit 1.

(0038)
In the embodiment, when the value Q that is stored in the non-volatile memory 21 is 10.5g/kg the charge potential VD of the photosensitive unit 1 is 370V. When the value Q is less than that, the charge potential VD of the photosensitive unit 1 decreases corresponding to the relationship shown in Fig 5. When the value Q is 10.5g/kg or greater, the charge potential VD of the photosensitive unit 1 is fixed at 370V. Also the laser power of the laser 13 is controlled so that all VL is 50V, and the DC component of the developing bias is set to 180V. The other developing bias conditions in the embodiment are frequency 2.7kHz, inter-peak voltage 1.5kV, duty 50% square wave.

(0039)
In a copier according to the embodiment, image formation is performed after potential is controlled using the primary current control value and the laser control value that were obtained by the aforementioned potential control.

(0040)
As mentioned above, developing characteristics are adjusted by using a developing contrast that is responsive to prior environment history.

(0041)
Next is a description of the toner supply installation.

(0042)
During the first installing or when installing a new toner supply for a developing unit, the serviceman selects the install toner supply mode from the service mode.

(0043)
In the embodiment, when the install toner supply mode is selected, the printer controller 6 loads the value that was written into the ROM 20 as the environment history initial setting, and writes this value into the non-volatile memory 21 as the value Q. In the embodiment, the value that is set is the one for moisture content 10.5g/kg, which is written as an initial value in the ROM 20, that is, one for which the charge potential of the photosensitive unit 1 becomes 370V.

(0044)
Next, after the toner supply installation is completed, potential control is performed during the rotation that precedes the first copy or print. At this time, the charge potential of the photosensitive unit 1 is controlled by loading the Q value in the non-volatile memory 21, that is the initial value that was written as Q, to set the target potential for the photosensitive unit 1. That is, after selecting a new toner supply installation, copying is performed with the photosensitive unit 1 having a charge potential of 37.0V.[4]

(0045)

[4] Assuming a type for 370.

Therefore, according to the embodiment, it is possible to select an appropriate developing condition, even when new developing agent is supplied in the developing device.

(0046)

(Second Embodiment)

A description of the second embodiment of the invention follows. In the case of constructions that are the same as in the first embodiment, the same marks are used, and the description is omitted.

(0047)

According to the embodiment, the initial value for moisture content that is written to the non-volatile memory 21 when the toner installation is replenished is not simply a value that corresponds to normal temperature and normal humidity; it also employs a value that takes into account developing characteristics that apply specifically after supply installation. Other device configurations and developing amount adjusting modes are the same as in the first embodiment.

(0048)

Concerning the following embodiment, the description is given under the condition that the environment is fixed to the same normal temperature and normal humidity (air humidity content 10.5g/kg) for both a conventional embodiment and for this embodiment.

(0049)

Fig 6 shows, for a conventional embodiment, that is one in which the moisture content value is not returned to the initial value after the toner supply is installed, the transition of the charge potential of the photosensitive unit 1 from the time that toner supply is installed to the time that 10,000 copies are made.

(0050)

As Fig 6 shows, the moisture content of the air of 10.5g/kg is, as stated above, uniform, and the charge potential of the photosensitive unit is uniform from the from the time that the toner supply is installed.

(0051)

Fig 7 shows the transition of transmission density from the time of the installation of toner to the 10,000th copy, given the charge potential of the photosensitive unit as shown in Fig 6.

(0052)

As Fig 7 shows, transmission density is high after the toner supply is installed. The amount of toner developed begins to decrease with the number of copies, and is substantially stabilized in the region of 3,000 copies.

(0053)

The cause of this phenomenon is that due to the mechanical stress between the developing sleeve when it rotates and the magnetic blade[5] that are provided in the developing unit, the silica or other external additives locally submerge under the surface of the toner. This effectively reduces the amount of external additive that has been added, decreasing toner fluidity. Thus there is insufficient triboelectric charge between the toner and the developing sleeve.

(0054)

On the other hand, in the case of the embodiment, the mechanical stress received during the external additive process at the time of manufacturing the toner is less that the mechanical stress received due to the rotation of the sleeve in the developing unit 4. Therefore, after the manufacture of the toner, compared to the condition inside the developing unit 4, fluidity is relatively high. Therefore, immediately after installing the supply, toner that is near the developing unit's sleeve has high fluidity and therefore exhibits high developing characteristics. However, as the number of copies increases, stress caused by the developing sleeve's rotation decreases developing characteristics.

(0055)

Toner near the developing sleeve is a mixture of toner that has received developing sleeve rotation stress, and toner that is newly supplied from the hopper, which has not received stress. When the amount of toner that is newly supplied per a number of copies is supplied under substantially uniform conditions, the average stress received by toner that is close to the developing sleeve stabilizes to a uniform value as the number of copies increases. That is, after a prescribed number of copies have been completed, the fluidity of toner on the developing sleeve reaches a constant state, and density stabilizes.

(0056)

After the toner supply is installed, as per the aforementioned description developing characteristics are high due to high fluidity. Concerning the amount of developing after the toner supply has been installed, a

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[5] Japanese word misspelled as Fred. Blade seems the only possibility.

setting is preferred that suppresses the amount of toner that is loaded, such as lowering the potential of the photosensitive unit.

(0057)

With the embodiment, after the toner supply is installed, the charge potential VD of the photosensitive unit 1 is set to 50V below the setting conditions that correspond normal temperature and normal humidity, or 320V. After that, based on the temperature and humidity detected by the environment sensor 19, the potential contrast is modulated by degrees, and optimum contrast is achieved because developing characteristics and adaptation to the surrounding environment occur concurrently.

(0058)

Fig 8 shows, according to the embodiment, the transition of the charge potential VD of the photosensitive unit 1 from the time that toner supply is installed until 10,000 copies are made.

(0059)

As Fig 8 shows, according to the invention, after the toner supply is installed, the initial value of the charge potential VD on the photosensitive unit 1 is 320V, and thereafter responsive to the value of the surrounding environment (steady environment of moisture content 10.5g/kg) the charge potential of the photosensitive unit 1 is increased by degrees.

(0060)

Fig 9 shows the transition of transmission density from the time that the toner supply is installed until 10,000 copies are made, given the charge potentials on the photosensitive unit 1 that are shown in Fig 8.

(0061)

As Fig 9 shows, with the embodiment the fluctuation in transmission density is less than in the conventional embodiment shown in Fig 7.

(0062)

Therefore, according to the embodiment, even in the case that new developing agent is supplied in the developing device, it is possible to select a developing condition that is even more appropriate than that in the first embodiment.

(0063)

Also this prevents the fluctuation in image density after the toner supply is installed that is caused by the affinity of the condition of the external toner additive to the rotation stress of the developing unit, stabilizing the amount of development after the toner supply is installed.

(0064)

In the embodiment the transmission density after the toner supply is installed is in the region of 2.0. However, in the case of toner made from another recipe, or even in the case of toner made with the same recipe but with different external additive conditions, or even in the case of toner made with the same recipe and the same external additive conditions, but if the device is different, or if the developing bias conditions are different, or if the developing contrast condition is different, it is natural that the transmission density will differ after the toner supply is installed, and the initial value should be set in accord with those conditions.

(0065)

The embodiment shows the case of adjusting the charge potential VD of the photosensitive unit 1 according to the environment, based on temperature and humidity detected by the environment sensor 19. However the invention can also be applied to the case of adjusting the DC component of the developing bias, or the developing bias frequency, waveform, etc as setting conditions for developing.

(0066)

Furthermore, with the invention it is also possible to adjust the circumferential speed of the developing sleeve relative to the circumferential speed of the photosensitive unit, or adjust the imaging signals used for exposing the photosensitive unit as a setting condition for developing.

(0067)

(Benefits of the Invention)

As described above, according to the invention in the application it is possible to select an appropriate developing condition even in the case in which new developing agent is supplied in a developing device.

Description of the Drawings

(Brief Description of the Drawings)

Fig 1 is a cross sectional diagram that shows the diagrammatic construction of an image-forming device according to the first embodiment of the invention.

Fig 2 is a block diagram that shows the diagrammatical construction of the control system of the image-forming device of Fig 1.
Fig 3 is diagram that shows the relationship between the time that the developing device is left after the installation environment of the developing device is changed and the transmission density of the image.
Fig 4 is a diagram that shows the relationship between the moisture content of the air in the environment in which the developing device is left and the transmission density of the image.
Fig 5 is a diagram that shows the relationship between the amount of atmospheric moisture, based on the temperature and humidity detected by the temperature and humidity detecting means, and the charge density on the latent image holding unit, according to the first embodiment of the invention.
Fig 6 is a diagram that shows the relationship between the number of formed images (number of copies) and the charge potential of the latent image holding device, according to a conventional embodiment.
Fig 7 is a diagram that shows the relationship between the number of formed images (number of copies) and the image transmission density, according to a conventional embodiment.
Fig 8 is a diagram that shows the relationship between the number of formed images (number of copies) and the charge potential of the latent image holding device, according to the second embodiment of the invention.
Fig 9 is a diagram that shows the relationship between the number of formed images (number of copies) and the image transmission density, according to the second embodiment of the invention.

(Description of the Marks)

1 Photosensitive unit (latent image holding unit)
4 Developing unit (developing device)
6 Printer controller (developing condition setting means)
9 Environment sensor (temperature, humidity detection means)

Fig 1

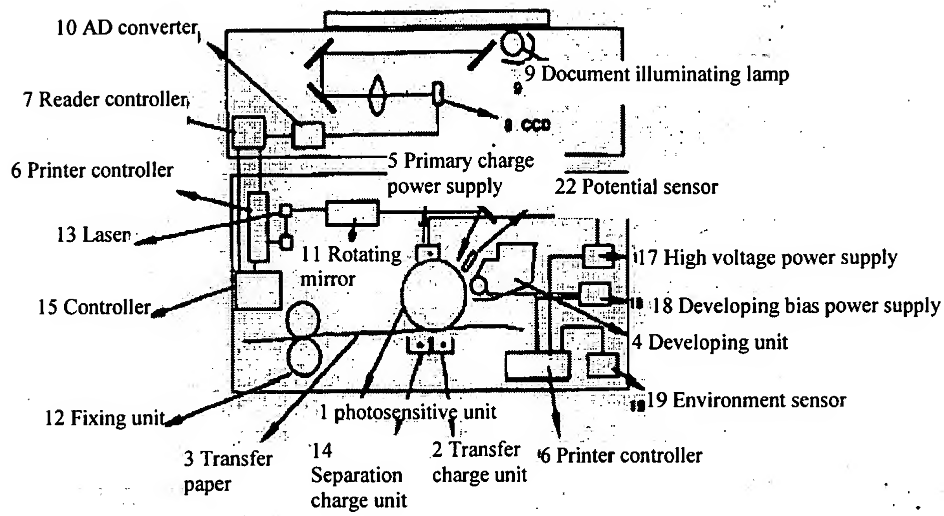

10 AD converter
9 Document illuminating lamp
7 Reader controller
8 CCD
6 Printer controller
5 Primary charge power supply
22 Potential sensor
13 Laser
11 Rotating mirror
17 High voltage power supply
15 Controller
18 Developing bias power supply
4 Developing unit
19 Environment sensor
12 Fixing unit
1 photosensitive unit
3 Transfer paper
14 Separation charge unit
2 Transfer charge unit
6 Printer controller

Fig 2

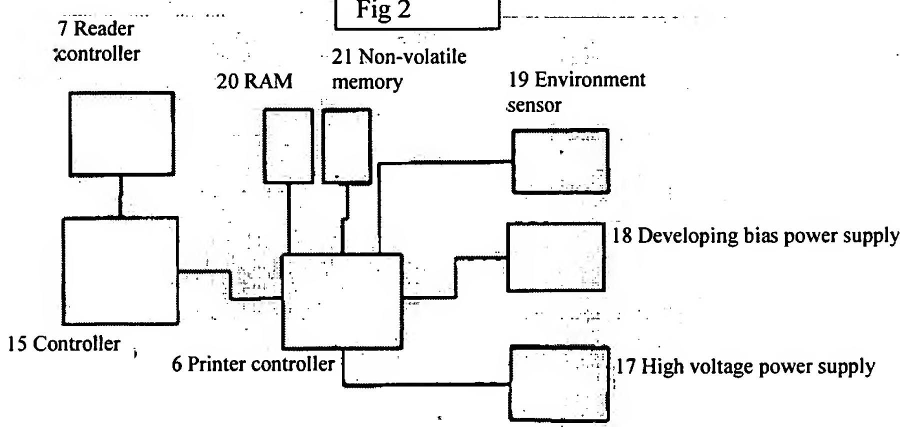

7 Reader controller
21 Non-volatile memory
20 RAM
19 Environment sensor
18 Developing bias power supply
15 Controller
6 Printer controller
17 High voltage power supply

Fig 3

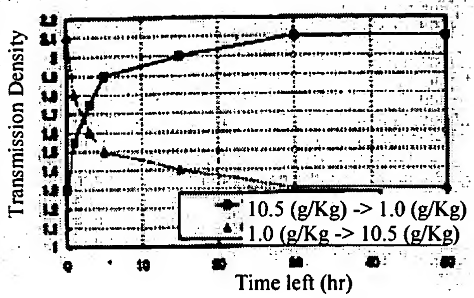
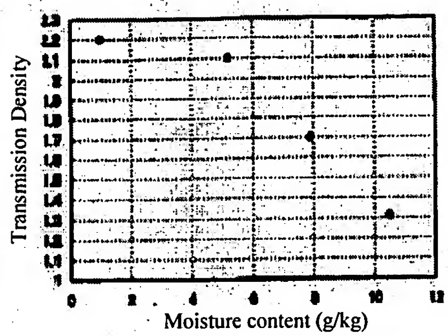
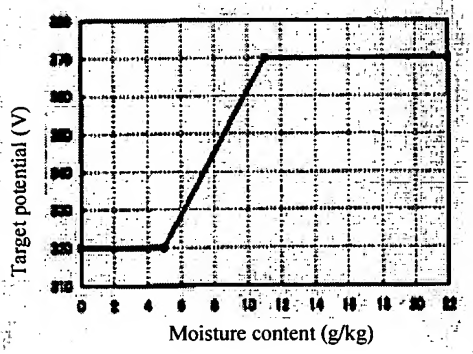


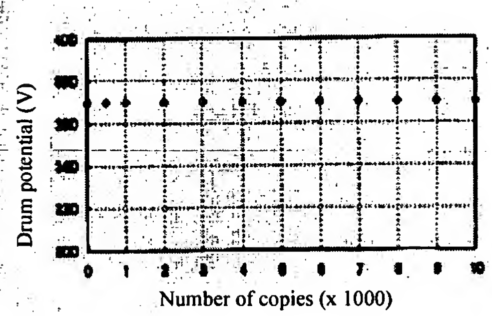
Fig 4



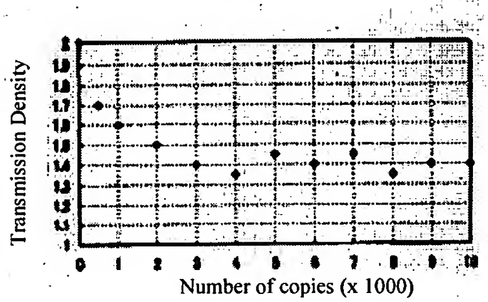
【図5】



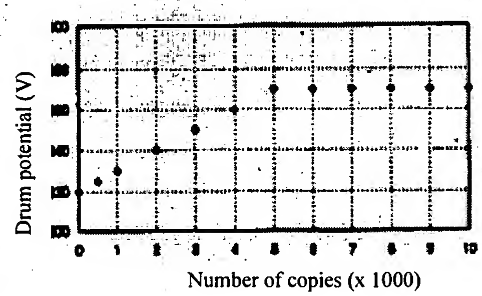
【図6】



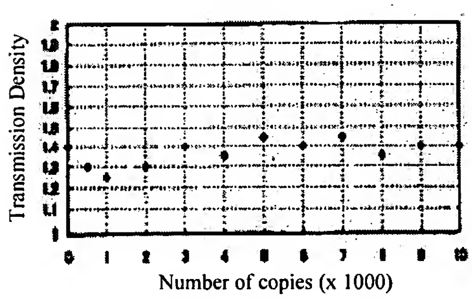
【図7】



【図8】



【図9】



((The contents of the box in Fig 3 are illegible. This is my guess from the content of the specification.))